Flow Rates for Faucets, Showers and Tub/Shower Combination Valves

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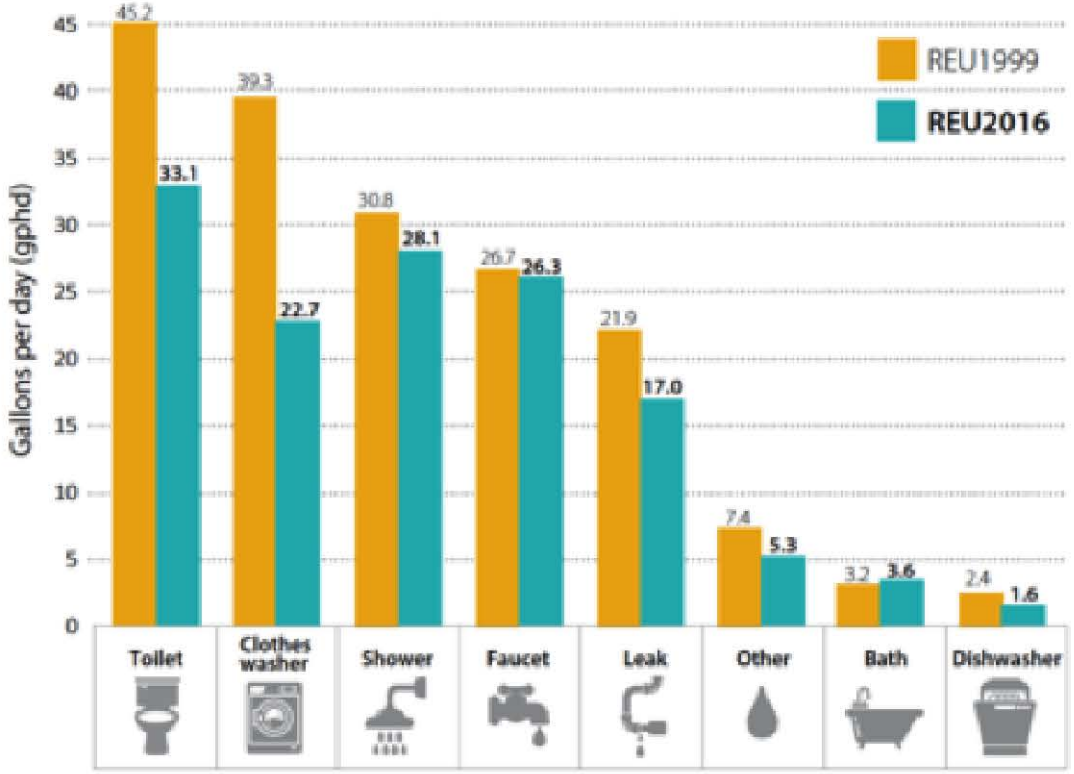
Daily Water Use 1999 vs. 2016

Figure 4. Average daily indoor per household water use
REU1999 and REU2016

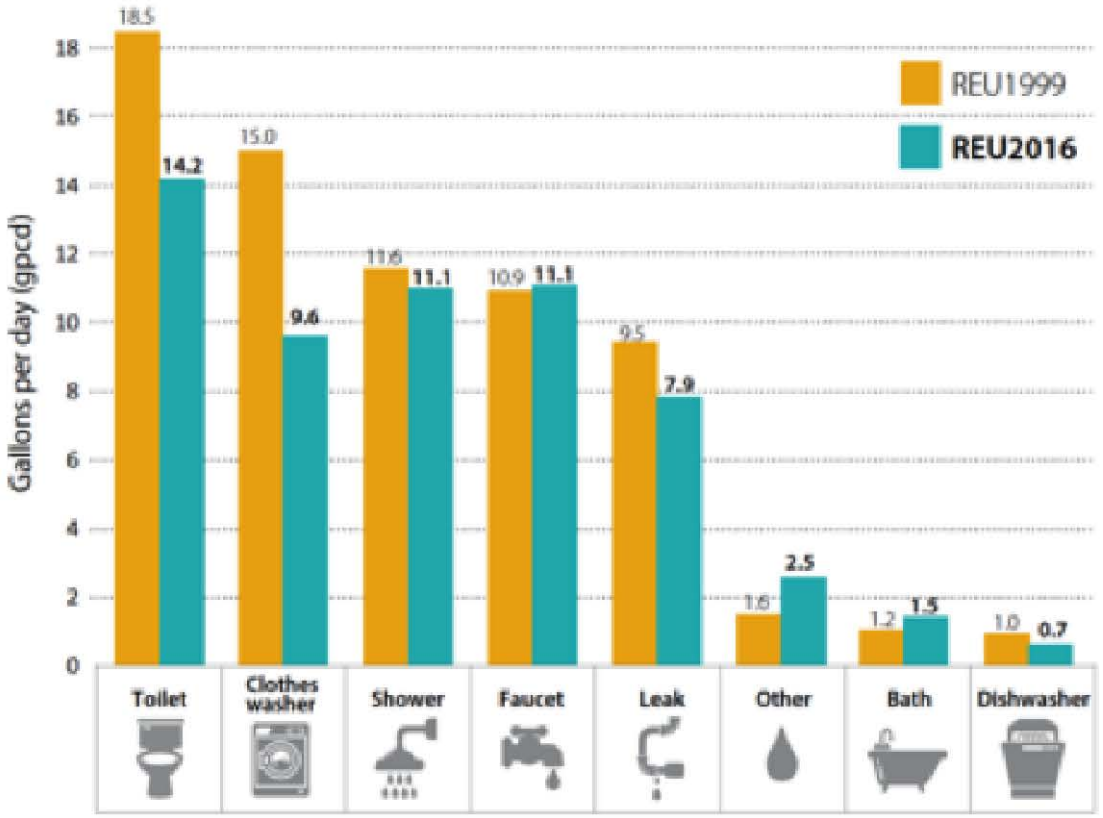


22%
DECREASE
PER HOUSEHOLD
DAILY WATER USE
1999 TO 2016

Source: Water Research Foundation, *2016 Residential End Uses of Water Study Update – Version 2 (Mayer et al. 2016),* http://www.waterrf.org/Pages/Projects.aspx?PID=4309)

Per Capita Water Use 1999 vs. 2016

Figure 5. Average daily indoor per capita water use
REU1999 and REU2016



15%
DECREASE
PER CAPITA
DAILY WATER USE
1999 TO 2016

Source: Water Research Foundation, *2016 Residential End Uses of Water Study Update – Version 2 (Mayer et al. 2016),* http://www.waterrf.org/Pages/Projects.aspx?PID=4309)

Water Consumption 1980-2017

Water-using Fixture or Appliance	1980s Water Use (typical)	1990 Requirement (maximum)	EPAct 1992 Requirement (maximum)	2009 Baseline Plumbing Code (maximum)	"Green Code" Maximums (2017 CALGreen)	% Reduction in avg water use since 1980s
Residential Bathroom Lavatory Faucet	3.5+ gpm	2.5 gpm	2.2 gpm	2.2 gpm	1.2 gpm	66%
Showerhead	3.5+ gpm	3.5 gpm	2.5 gpm	2.5 gpm	1.8 gpm	49%
Residential ("private") Toilet	5.0+ gpf	3.5 gpf	1.6 gpf	1.6 gpf	1.28 gpf	74%
Commercial ("public") Toilet	5.0+ gpf	3.5 gpf	1.6 gpf	1.6 gpf	1.28 gpf	74%
Urinal	1.5 to 3.0+ gpf	1.5 to 3.0+ gpf	1.0 gpf	1.0 gpf	0.125 gpf	96%
Commercial Lavatory Faucet	3.5+ gpm	2.5 gpm	2.2 gpm	0.5 gpm	0.5 gpm	86%
Food Service Pre-Rinse Spray Valve	5.0+ gpm	No requirement	1.6 gpm *(EPAct 2005)*	No requirement	1.3 gpm	74%
Residential Clothes Washing Machine	51 gallons per load	No requirement	26 gallons per load *(2012 std)*	No requirement	12.6 gallons per load *(Energy Star)*	75%
Residential Dishwasher	14 gallons per cycle	No requirement	6.5 gallons per cycle *(2012 std)*	No requirement	3.5 gallons per cycle *(Energy Star)*	75%

From 1980 to 2017: Reductions range from 49 to 96%

Source: *The Drainline Transport of Solid Waste in Buildings*, PERC 1 Report - J. Koeller, P. DeMarco

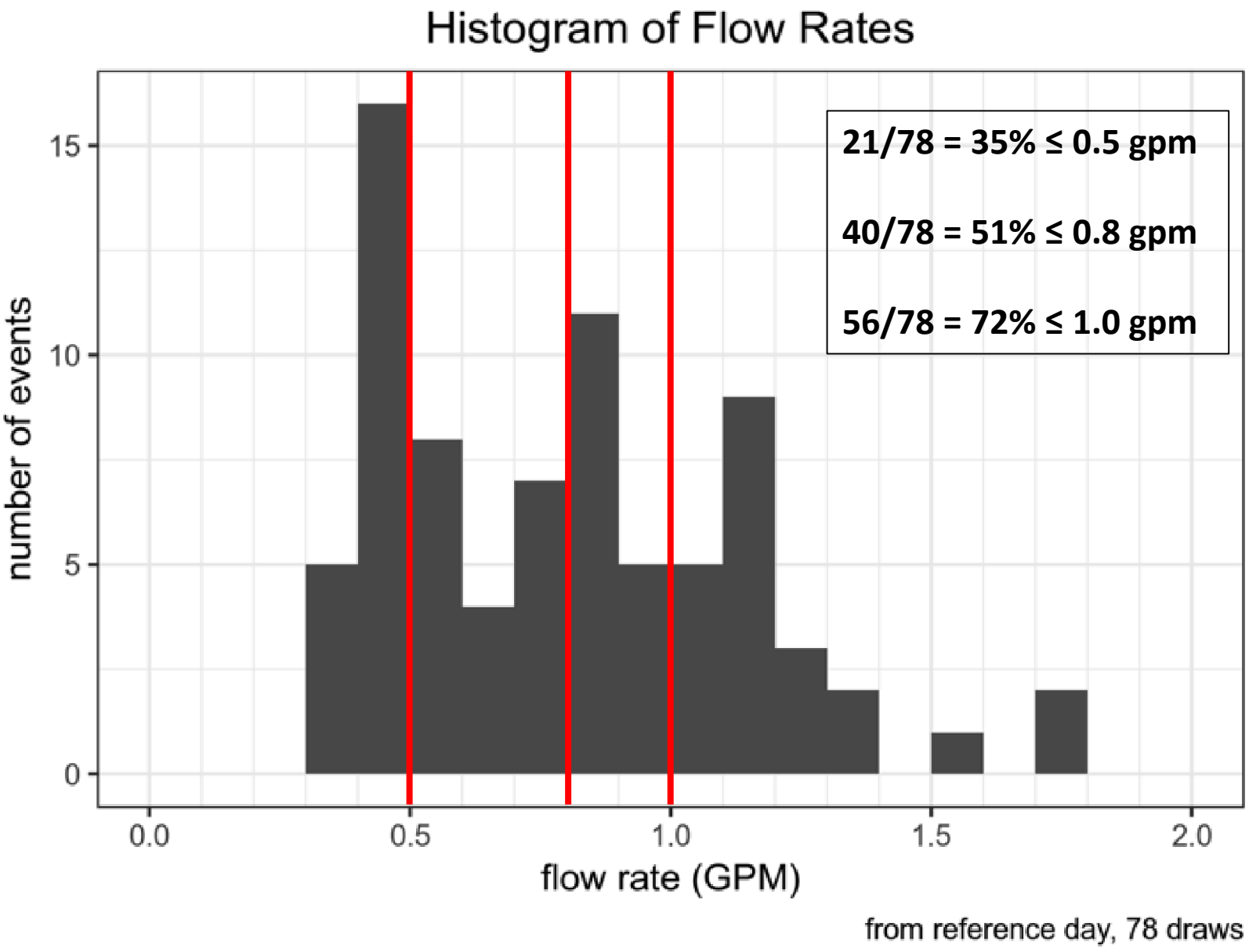
Daily Draw Patterns from CBECC-Res

-

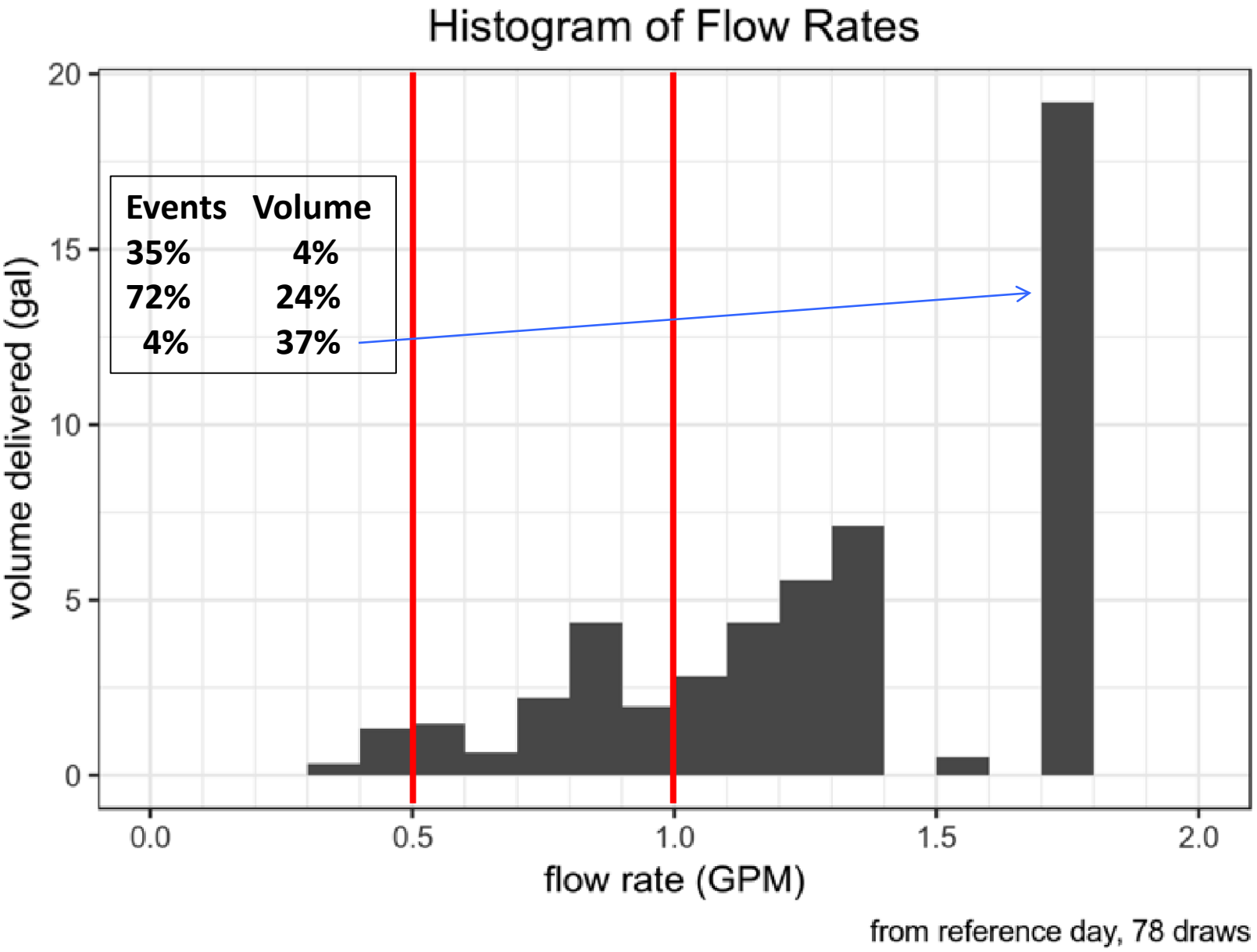
Day	People	Day of Week	Daily Volume of Water (gal)	Number of Daily Draws					
				Total	Shower	Faucet	CW	DW	Bath
1	2	Wed	25.53	28	1	23	4	0	0
2	2	Sat	47.57	94	0	81	6	6	1
3	3	Thu	95.91	106	4	87	10	4	1
4	3	Thu	52.29	77	2	70	5	0	0
5	4	Mon	75.05	31	2	17	12	0	0

CW = Clothes Washer, DW = Dishwasher,

Number of Events by Volume



Volume Delivered by Flow Rate



Flow Rates for Faucets, Tubs and Showers

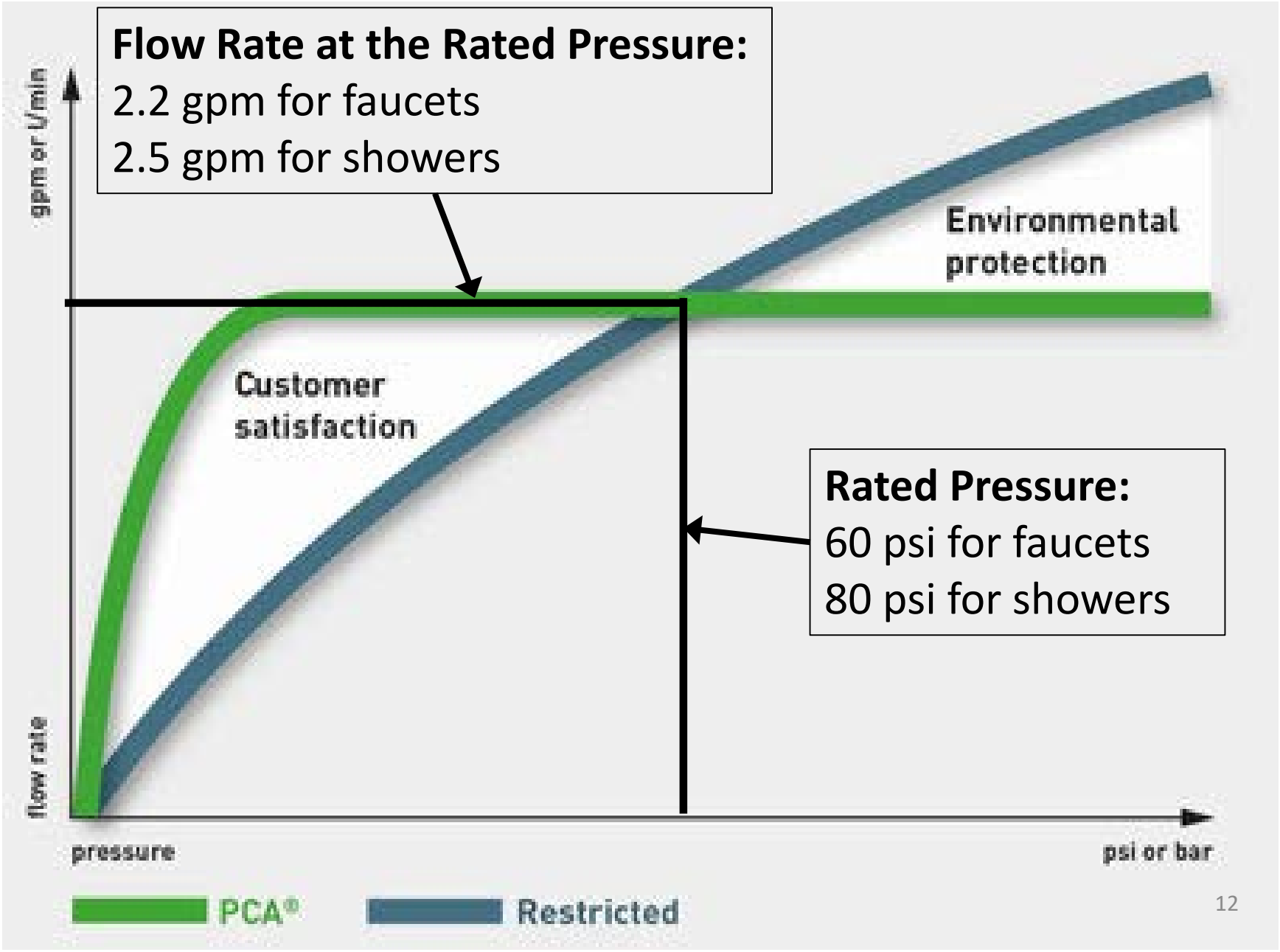
Fixture	Flow Rate-Rated (gpm)	Flow Rate- All Hot (gpm)
Shower- stand alone	2.0 [1.0-2.5]	1.4 [60%-80%]
Tub/shower combination	5.0 [4.0-6.0	3.5 [60%-80%]
Lavatory faucet	1.5 [0.5-2.2]	1.5 [100%]
Kitchen faucet	2.0 [1.5-2.2]	2.0 [100%]

Fixed vs. Variable Orifices

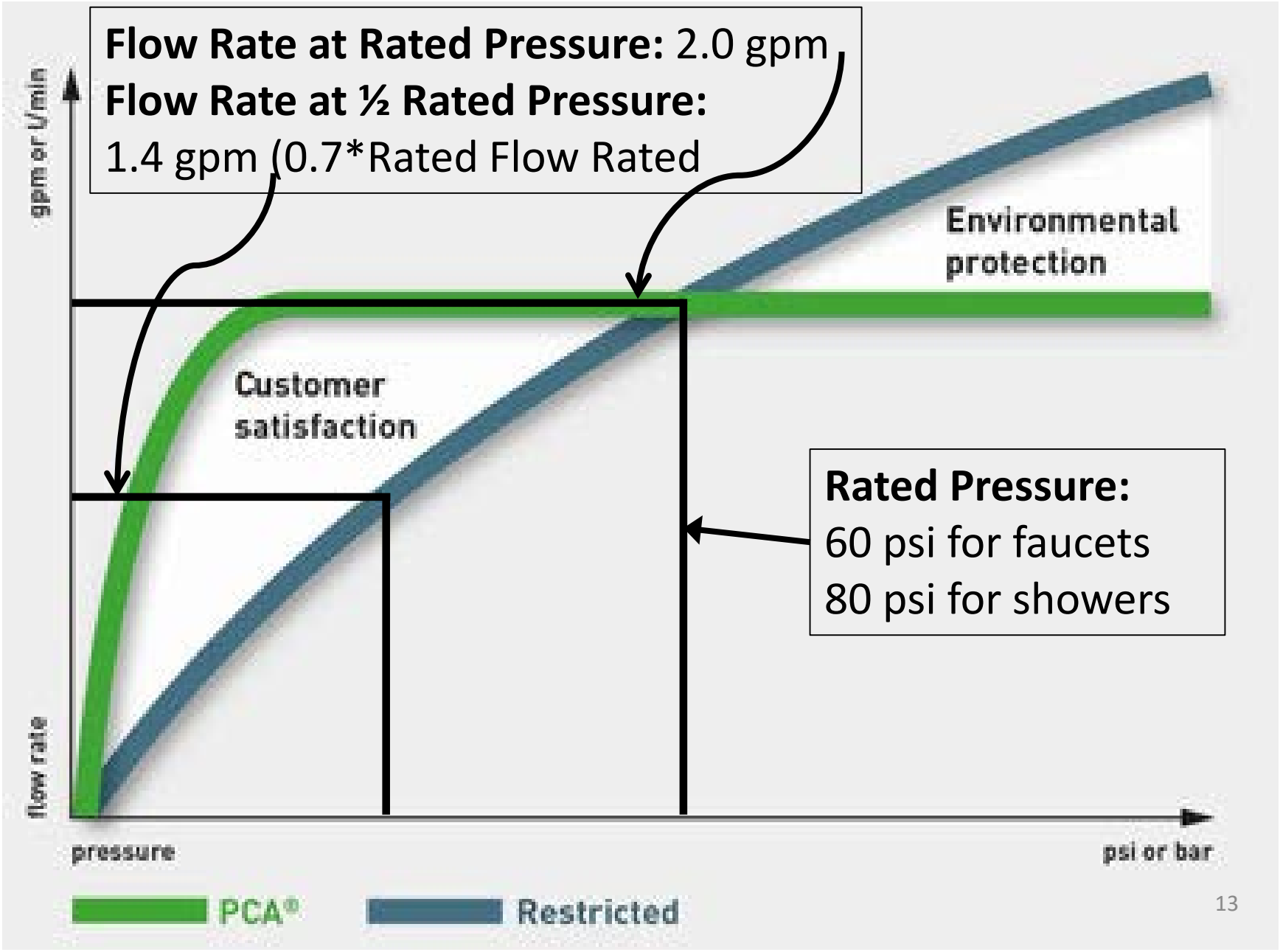
- **Fixed Orifice:**
  - High pressure: High flow rate
  - Low pressure: Low flow rate
  - Before 2000, practically all fixture fittings and appliances
- **Pressure Compensating Aerators**
  - Adjusts flow rate to compensate for available pressure
  - Almost the same flow rate for all pressures above 20-25 psi
  - Ramped up from 2000-2012 for showerheads
  - Today more than 90% and many faucet aerators

Pressure Compensating Aerators - 1

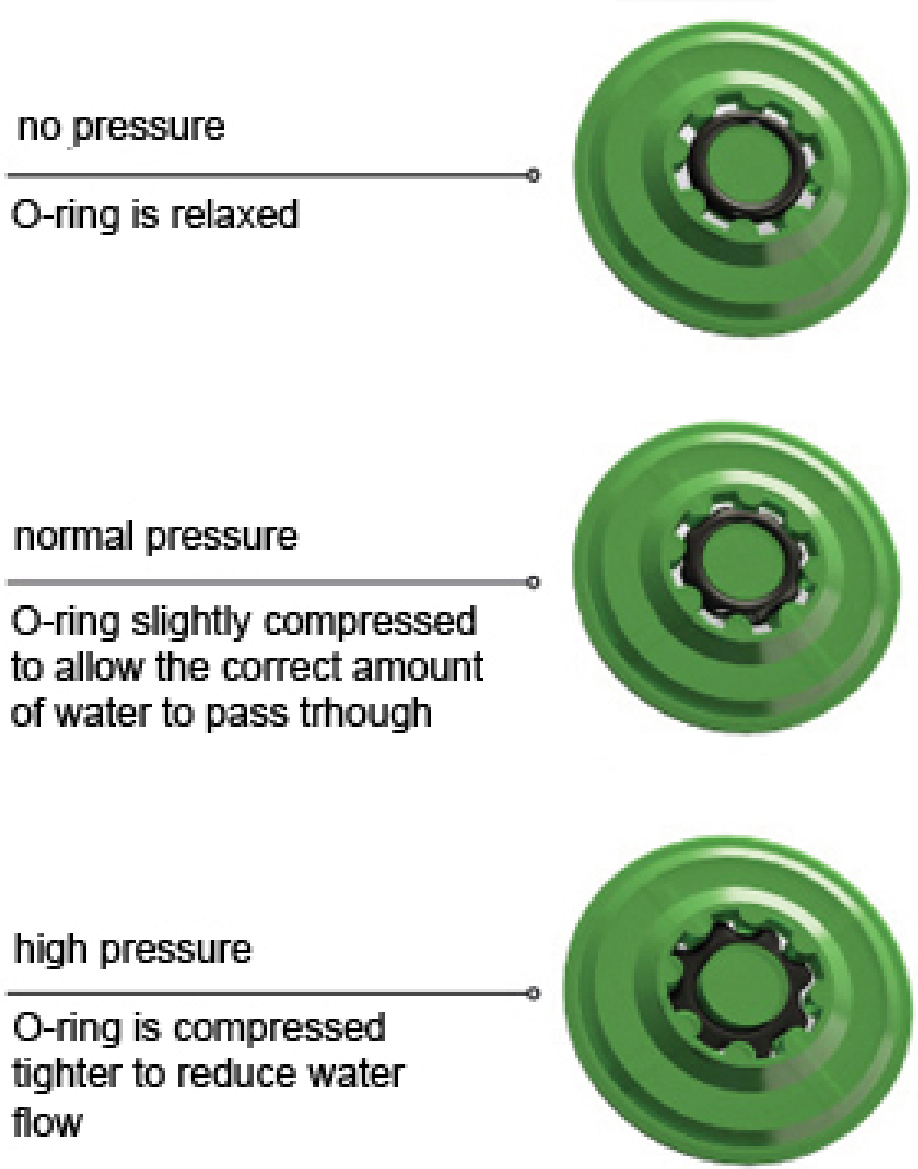
Pressure Compensating Aerators - 2



Pressure Compensating Aerators - 3



Pressure Compensating Aerators - 4

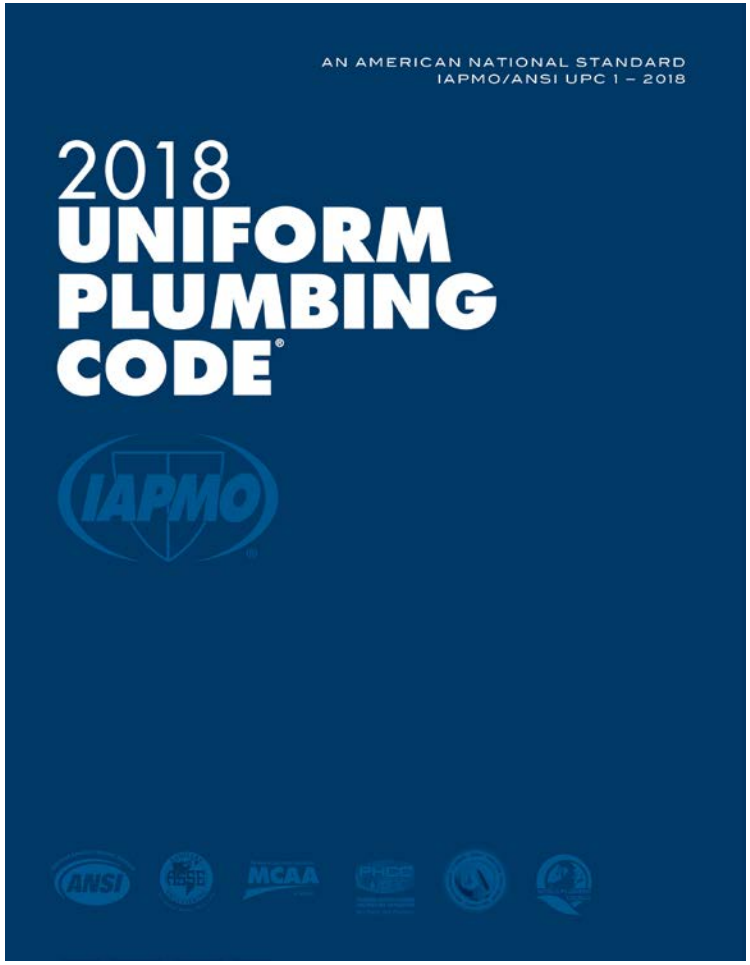


A pressure compensating flow regulator maintains a constant flow regardless of variations in line pressure thereby optimizing system performance and comfort of use at all pressures.

Source: Neoperl's website for this and the pressure-flow diagrams

Pipe Sizing for Peak Flows

Standard Method



Appendix M: Water Demand Calculator

↓ Select Units ↓

Tuesday, July 24, 2018 11:04 PM

PROJECT NAME : XXX-XXX

GPM | LPM | LPS

FIXTURE GROUPS		[A] FIXTURE	[B] ENTER NUMBER OF FIXTURES	[C] PROBABILITY OF USE (%)	[D] ENTER FIXTURE FLOW RATE (GPM)	[E] MAXIMUM RECOMMENDED FIXTURE FLOW RATE (GPM)
Bathroom Fixtures	1	Bathtub (no Shower)	0	1.0	5.5	5.5
	2	Bidet	0	1.0	2.0	2.0
	3	Combination Bath/Shower	0	5.5	5.5	5.5
	4	Faucet, Lavatory	0	2.0	1.5	1.5
	5	Shower, per head (no Bathtub)	0	4.5	2.0	2.0
	6	Water Closet, 1.28 GPF Gravity Tank	0	1.0	3.0	3.0
Kitchen Fixtures	7	Dishwasher	0	0.5	1.3	1.3
	8	Faucet, Kitchen Sink	0	2.0	2.2	2.2
Laundry Room Fixtures	9	Clothes Washer	0	5.5	3.5	3.5
	10	Faucet, Laundry	0	2.0	2.0	2.0
Bar/Prep Fixtures	11	Faucet, Bar Sink	0	2.0	1.5	1.5
Other Fixtures	12	Fixture 1	0	0.0	0.0	6.0
	13	Fixture 2	0	0.0	0.0	6.0
	14	Fixture 3	0	0.0	0.0	6.0

Total Number of Fixtures 0

99th PERCENTILE DEMAND FLOW = GPM

RESET | RUN WATER DEMAND CALCULATOR

↑ CLICK BUTTON ↑

http://www.iapmo.org/Pages/WaterDemandCalculator.aspx

There is a Limit to How Low We Can Go.

- Unless the heater is in the fixture or appliance, there will always be some volume in the pipe between the source and the use.
- It takes roughly twice the volume in the pipe for hot water to come out the other end.
- We need to decide what is an “acceptable” time-to-tap or volume-until-hot and work backwards to determine the maximum allowable in the pipe between the source and the use.
  - Plumbing up from below needs about 5 feet of pipe.
  - Plumbing down from above needs about 10 feet of pipe

Time-to-Tap, Volume-until-Hot – 5 ft. of Pipe

Pipe Material	Pipe Diameter (nominal, inches)				
	0.25	0.375	0.5	0.75	1
Gallons to Hot: 5 Feet of Pipe					
Copper-Type L	0.04	0.08	0.12	0.25	0.43
CPVC	NA	NA	0.10	0.21	0.35
PEX	0.03	0.05	0.09	0.18	0.31
Time to Hot @ 0.5.gpm: 5 Feet of Pipe (seconds)					
Copper-Type L	5	9	15	30	51
CPVC	NA	NA	12	25	42
PEX	3	6	11	22	37
Time to Hot @ 1.0 gpm: 5 Feet of Pipe (seconds)					
Copper-Type L	2	5	7	15	26
CPVC	NA	NA	6	13	21
PEX	2	3	6	11	18

Time-to-Tap, Volume-until-Hot – 10 ft. of Pipe

Pipe Material	Pipe Diameter (nominal, inches)				
	0.25	0.375	0.5	0.75	1
Gallons to Hot: 10 Feet of Pipe					
Copper-Type L	0.08	0.15	0.24	0.50	0.86
CPVC	NA	NA	0.20	0.42	0.69
PEX	0.05	0.10	0.18	0.37	0.61
Time to Hot @ 0.5.gpm: 10 Feet of Pipe (seconds)					
Copper-Type L	10	18	29	60	103
CPVC	NA	NA	23	50	83
PEX	6	12	22	44	73
Time to Hot @ 1.0 gpm: 10 Feet of Pipe (seconds)					
Copper-Type L	5	9	15	30	51
CPVC	NA	NA	12	25	42
PEX	3	6	11	22	37

How Low Can We Go? How Close Can We Get?

- The shorter the pipe, the less time it takes.
- The lower the flow rate, the longer it takes.
- How long is too long?
  - 5 seconds?
  - 10 seconds?
  - Longer?

Water, energy and time efficient hot water systems start with deciding how long we want people to wait.